5 IMPROVING SYSTEM PERFORMANCE

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Delay is the traditional measure of NAS performance, but the FAA is beginning to broaden its perspective to take into account the interactions among capacity, demand, and delay, and other aspects of system performance such as flexibility and access to airports, airspace, and aviation services. This chapter presents system performance data related to delay and the demand/delay trade-off, describes significant new FAA initiatives for enhancing system performance in the near-term, and summarizes Department of Transportation intermodal strategies.

5.1 Demand, Capacity, and Delay

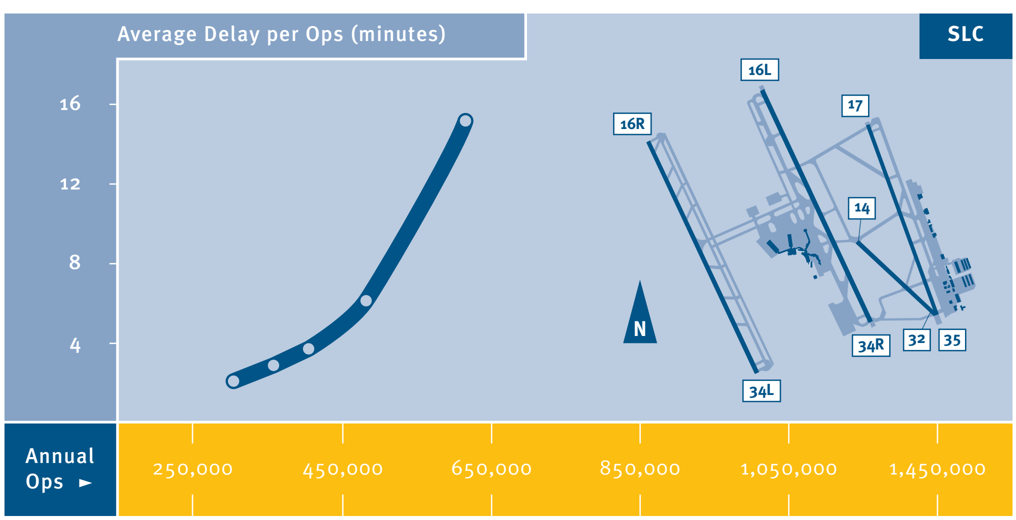
During a given hour, if aircraft using an airport sought service at a continuous rate equal to that at which aircraft operations could be processed, and if operating conditions at the airport were constant throughout the hour, then operations could reach the airport's highest capacity without significant delays. However, the rate at which aircraft arrive and depart is never continuous. There are periods during an hour when several aircraft demand service at the same time and periods when none arrive or depart. Therefore, the number of operations an airport actually processes usually is less than the airport's highest capacity, even when the weather is favorable.

As demand approaches airport capacity, some delays related to congestion will occur. However, if demand begins to exceed airport capacity, delays will become more significant and occur at an increasing rate. The FAA models the relationship between capacity, increasing demand, and delay in its Airport Capacity Enhancement Design Team studies. The FAA's NAS Advanced Concepts Branch recently used the same methodology to calculate Annual Service Volumes (ASV) for the top 25 airports, two examples of which are presented here. By performing a series of simulations with increasing demands, they developed a series of demand/delay curves that show average delay per operation as a function of the number of annual operations, from which ASVs can be determined.

Figure 5-1 presents Annual Service Volume estimates and demand/delay curves for Salt Lake City International Airport (SLC). The figure shows that average delays at SLC are modest until annual operations exceed 450,000. Without capacity improvements, the average delay per operation increases rapidly as annual operations exceed 500,000. There is a trade-off between demand and delay, with increases in demand being accommodated only at the cost of increased delay.

Figure 5-1

Annual Service Volume Estimates: Annual Demand and Delay at Salt Lake City International Airport



An airport can meet increased demand without incurring large delays by increasing its capacity. Since the most effective way to increase capacity is to build additional runways, the FAA developed demand/delay curves for selected airports assuming the construction of new runways. Figure 5-2 illustrates the impact of the construction of a new runway at Orlando International Airport (MCO): the demand/delay curve moves significantly to the right. The shift indicates that a new runway would allow more operations to be accommodated with fewer delays. With the present runway infrastructure, delays at MCO are estimated to begin to increase rapidly when operations exceed 600,000 annual operations. With a new runway, the airport would be able to accommodate that level of operations without difficulty and delays are not projected to reach a significant level until operations approach 850,000 per year.

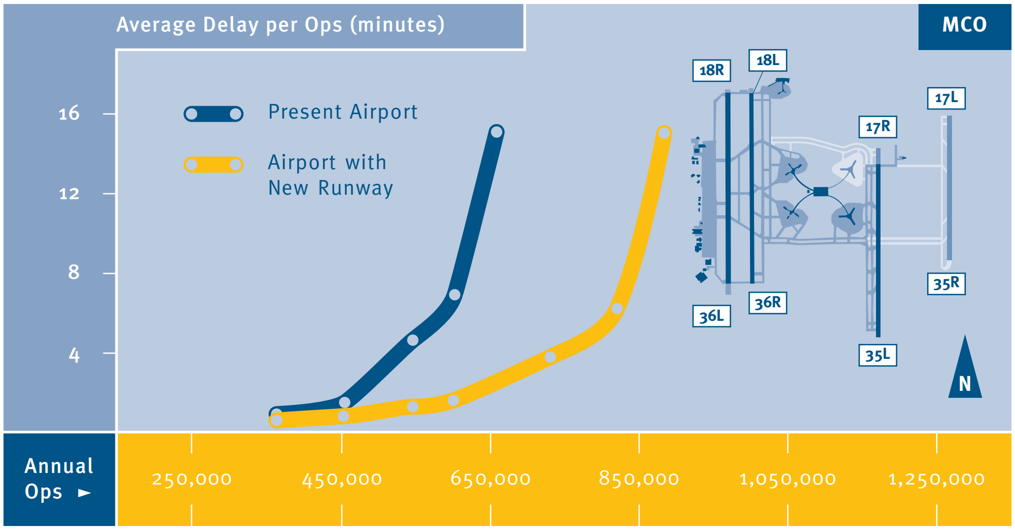


Figure 5-2
Annual Service Volume Estimates: Impact of a New Runway at Orlando International Airport

5.2 Delays in the National Airspace System

The FAA uses two different systems to track delays, the Operations Network (OPSNET) and the Consolidated Operations and Delay Analysis System (CODAS). OPSNET data come from observations by FAA personnel, who manually record aircraft that are delayed by 15 minutes or more during any phase of flight. Aircraft that are delayed by less than 15 minutes in any phase of flight are not recorded. OPSNET also provides information on the cause of delay: weather, volume, closed runways/taxiways, NAS equipment interruptions, and other. OPSNET reports delays for specific airports, but does not report delay by carrier or by flight.

According to OPSNET data, 374,116 flights were delayed 15 or more minutes in 1999, an increase of 22 percent over the 306,234 flights delayed in 1998. Figure 5-3 shows the trends in the distribution by cause of flights delayed 15 minutes or more for the last four years and the first nine months of 2000. The primary causes of delay vary little year over year, with a large majority of delays attributed to weather and a smaller but significant percentage to volume.

Figure 5-3
Annual Delays by Cause

Cause	1996	1997	1998	1999	Jan-Sept 2000(p)
Weather	200,930	166,783	227,764	257,261	254,193
	74.0%	68.0%	74.4%	68.8%	70.9%
Volume	50,108	54,415	44,932	44,317	43,670
	18.5%	22.2%	14.7%	11.8%	12.2%
NAS Equipment	5,873	6,394	5,962	7,709	5,626
	2.2%	2.6%	1.9%	2.1%	1.6%
Runway	5,947	8,073	8,268	17,422	20,986
	2.9%	3.3%	2.7%	4.6%	5.8%
Other	6,649	9,594	19,308	47,407	33,905
	2.4%	3.9%	6.3%	12.7%	9.5%
Total Delays ➤	**271,507**	**245,259**	**306,234**	**374,116**	**343,124(p)**

(p): preliminary numbers

Although an annual summary provides a useful guide to the trends in delays over time, the number of delays also varies substantially by month. Figure 5-4 shows the number of delays by month for the last four years and for the first nine months of 2000. The greatest number of delays generally occur during the summer months, when afternoon thunderstorms are prevalent.

Figure 5-4
Delays by Month

	1996	1997	1998	1999	Jan-Sept 2000(p)
January	25,082	21,588	27,623	24,345	26,015
February	18,955	15,856	24,855	19,851	27,208
March	18,598	15,055	24,159	23,180	32,205
April	19,303	17,453	22,563	34,046	35,332
May	22,200	19,177	29,187	39,533	36,570
June	29,776	25,068	37,093	41,602	50,114
July	25,544	26,193	25,672	45,162	44,430
August	24,203	24,816	30,549	37,189	47,893
September	25,422	19,388	20,194	32,833	43,357(p)
October	21,452	17,812	23,988	28,223	N/A
November	17,294	22,337	20,439	23,330	N/A
December	23,678	20,516	19,912	24,822	N/A
Total Delays ➤	**271,507**	**245,259**	**306,234**	**374,116**	**343,124(p)**

(p): preliminary numbers

CODAS provides information on delay by phase of flight by tracking all aircraft movements that exceed scheduled or unimpeded times. CODAS receives actual times for gate out, wheels off, wheels on, and gate in. From this information, supplemented by data from other databases, CODAS calculates the actual delays that a flight experiences as it moves through the NAS. Figure 5-5 ranks the large-hub airports by average delay for each phase of flight and by operation (arrivals plus departures). In general, taxi-out delays are longer than airborne or taxi-in delays. LaGuardia and Newark airports have the largest taxi-out delays of the large-hub airports as well as the largest delays per operation.

Figure 5-5
Delays by Phase of Flight

Taxi Out Delay		Airborne Delay		Taxi In Delay		All Phases	
Airport	Min/Dep	Airport	Min/Arr	Airport	Min/Arr	Airport	Min/Op
LGA	13.2	EWR	6.4	DTW	3.4	EWR	11.3
EWR	13.0	ATL	6.2	DFW	3.3	LGA	10.4
PHL	8.3	PHL	5.5	LAX	2.8	ATL	8.7
ATL	8.2	LGA	4.8	EWR	2.6	PHL	8.5
DTW	7.7	IAD	4.7	ATL	2.4	DTW	7.4
JFK	7.6	MSP	4.4	ORD	2.4	MSP	7.0
MSP	7.1	SEA	4.3	STL	2.2	ORD	7.0
ORD	7.0	BOS	4.3	BOS	2.1	BOS	7.0
STL	6.9	ORD	4.1	MSP	2.1	JFK	7.0
BOS	6.5	JFK	3.8	PHL	2.0	STL	6.5
DFW	6.0	SLC	3.8	LGA	2.0	DFW	6.2
CVG	5.9	CVG	3.8	MIA	1.9	IAD	6.1
IAH	5.5	SFO	3.4	PHX	1.9	LAX	5.8
IAD	5.4	CLT	3.3	JFK	1.8	CVG	5.6
PHX	5.2	STL	3.2	IAH	1.6	IAH	5.5
SFO	5.1	DTW	3.2	LAS	1.5	PHX	5.3
DCA	4.9	IAH	3.1	DEN	1.4	MIA	5.2
LAX	4.9	PIT	3.1	SFO	1.3	SFO	5.2
MIA	4.6	MIA	3.0	SLC	1.0	SEA	4.7
PIT	4.3	LAX	2.9	SEA	1.0	SLC	4.7
LAS	4.1	FLL	2.7	CLT	0.9	DCA	4.5
CLT	3.8	DFW	2.7	IAD	0.9	PIT	4.4
SLC	3.8	DEN	2.5	PIT	0.9	CLT	4.4
DEN	3.6	PHX	2.5	DCA	0.9	FLL	4.2
FLL	3.5	DCA	2.3	FLL	0.9	DEN	4.1
SEA	3.4	MCO	2.3	MCO	0.8	LAS	4.0
MCO	3.1	TPA	2.1	BWI	0.8	MCO	3.6
BWI	2.8	BWI	1.9	CVG	0.7	BWI	3.2
SAN	2.6	SAN	1.3	TPA	0.6	SAN	3.0
TPA	2.2	LAS	1.3	SAN	0.5	TPA	2.9

Excludes HNL

Taxi-Out Delay: Actual Taxi-Out Time Minus Unimpeded Taxi-Out Time

Airborne Delay: Actual Airborne Time Minus Carrier Submitted Flight Plan Time

Taxi-In Delay: Actual Taxi-In Time Minus Unimpeded Taxi-In Time

All Phases: Delay Per Operation that is Attributed to Weather and ATC

5.3 Strategies to Improve System Performance

The FAA has recently undertaken several significant initiatives to improve system performance in the near-term by working closely with NAS users and taking maximum advantage of the airspace, facilities, and equipment that are currently available. In addition, Department of Transportation initiatives to increase the performance of the overall transportation system, by capitalizing on the synergistic benefits of intermodal transportation, will enhance the performance of the aviation system.

5.3.1 The Spring/Summer Plan

In the fall of 1999, the FAA and representatives of the airline industry met to discuss the severe delays experienced during the summer of 1999. In response, the FAA proposed a series of initiatives to lessen the delays, some of which were implemented at that time. In April 2000, the President announced an initiative called the Spring/Summer Plan that proposed additional remedies. The Spring/Summer Plan is a joint FAA/industry plan designed to mitigate the effects of severe weather on the NAS through a re-commitment to collaborative decision making between the FAA and the airlines and other NAS users. Although primarily intended as a means of maintaining system predictability and capacity in times of severe weather, the improved planning, communication, and information dissemination processes that form the backbone of the Spring/Summer Plan should provide system efficiencies at other times as well. Key elements of the Spring/Summer Plan are described below.

Strategic Planning

A strategic planning team at the Air Traffic Control System Command Center (ATCSCC) conducts a conference call every two hours, from 7 a.m. to 9 p.m., with airline and air traffic control representatives. During the call, the participants generate two- and six-hour system plans, taking into consideration potential problems caused by adverse weather or high traffic volume. The resulting strategic plan is posted on the ATCSCC web site.

Route Coordination

The FAA and the airlines worked together to develop routing alternatives to facilitate efficient re-routing of traffic during severe weather. Coded departure routes (CDR) help mitigate delays by balancing traffic at available departure fixes within 200 nautical miles of the affected airport. The national playbook provides route alternatives to address the most common severe weather scenarios facing en route and arrival traffic. For example, 114 possible routes from Boston Logan International airport to 38 destination airports in the U.S. have been developed. The availability of a variety of pre-determined alternate routes provides flexibility in dealing with most severe weather events and expedites the route coordination process. It also allows airlines to plan ahead for possible route changes when severe weather is forecast. The coded departure routes and the national playbook are available on the ATCSCC web site.

Collaborative Convective Forecast Product

In the past, effective collaboration and planning of NAS operations during severe weather has been limited by conflicting convective weather forecasts. In response, the FAA has developed the Collaborative Convective Forecast Product (CCFP), a system for developing and distributing a single convective forecast four times a day. This forecast is based on input from the National Weather Service's Aviation Weather Center (AWC), the ARTCCs' Center Weather Service Units (CWSU), and airline meteorologists. The forecast covers the continental U.S., its coastal waters, and portions of Canadian airspace that are commonly used by U.S. aircraft during severe weather. Collaborative forecasts for the New York, Washington, Chicago, and Dallas areas are given top priority.

The Aviation Weather Center produces the original forecast, which is then reviewed with CWSU and airline meteorologists on an internet chat room. The AWC revises the original forecast to produce a final collaborative forecast, which is then displayed on the internet. The collaborative forecast is used by both the FAA and airline dispatchers to determine when and where to re-route traffic, cancel flights, or implement air traffic restrictions such as ground delay programs.

Improved Access to East Coast Military Airspace

The FAA and U.S. Navy have signed a letter of agreement regarding civilian use of offshore warning area airspace from Northern Florida to Maine during severe weather events. The letter specifies coordination procedures so that civilian flights can be routed through the warning area to avoid severe weather if it is not being used by the military at that time. To facilitate use of this airspace, the FAA has established waypoints along several routes for conducting point-to-point navigation when the DoD has released that airspace to the FAA. The waypoints take advantage of aircraft RNAV capabilities and provide a better demarcation of airspace boundaries, enabling a more flexible release of airspace in response to changing weather.

Improved Flight Planning Procedures

The lack of complete and accurate flight information reduces the effectiveness of traffic management decisions, thus limiting NAS efficiency and capacity. Before a flight plan is filed, traffic managers base their projections on traffic patterns from the previous 15 days. To improve the information available for planning purposes, the FAA has requested that users file their IFR flight plans at least four hours prior to departure. In addition, the FAA has requested that users who want to amend their flight plan within 45 minutes of departure call in the change to the appropriate facility instead of filing the amendment electronically, to ensure that the new flight plan information is available to air traffic controllers.

Low Altitude Alternate Departure Route

A relatively new procedure, the Low Altitude Alternate Departure Route (LAADR), is helping to relieve congestion in high altitude sectors and avoid departure delays. Under LAADR, pilots request lower-than-normal altitudes of 18,000 to 23,000 feet instead of the higher, busier altitudes. The ATCSCC makes the LAADR procedure available to pilots when a large volume of departure and high-altitude traffic is expected. When the LAADR procedure is in effect, pilots have the option of filing for high altitudes and accepting a departure delay, or requesting a lower initial altitude and being able to enter the high-altitude traffic stream when space is available.

The LAADR procedure has been used primarily with departures, but it can be extended for the entire flight. Flying at lower altitudes typically adds several minutes to the flight time and increases fuel consumption, but these costs may be outweighed by the opportunity to depart on time and to fly through less congested airspace. First implemented in New York area, LAADR is now available over the eastern half of the United States. Airlines that are using the procedure report that it helps keep traffic moving.

Diversion Recovery

During severe weather, flights are frequently diverted to alternate airports to avoid unsafe flying or landing conditions. The goal of diversion recovery is to ensure that flights that have already been penalized by having to divert to another airport do not receive additional penalties or delays. Diversion recovery is coordinated by the ATCSCC and system users. Airlines identify a diverted flight in the remarks section of its flight plan and the ATCSCC posts a list of diverted flights on its web site. Airlines review the list, add missing flights, annotate their flight priorities, and then fax the list to the ATCSCC. The ATCSCC forwards the prioritized list of flights to the appropriate ARTCCs, which in turn forward the list to the appropriate TRACONs and towers. All air traffic facilities provide priority handling to those flights identified on the distributed list or by the use of "DVRSN" in the flight plan.

User Hotline

During periods of rapidly changing conditions, the FAA activates a user hotline to provide timely operational information to the user community. Users can call the hotline to raise flight-specific or event-specific issues with an ATCSCC customer advocate.

Post Event Analysis

A team of FAA and aviation industry representatives meet twice per month to review NAS performance, with the intent of developing ideas for improving existing procedures and to develop a more efficient airspace system. Background data to support the system performance analysis is collected from the ATCSCC, air traffic facilities, and the airlines.

5.3.2. The National Choke Points Initiative

The National Choke Points Initiative was conceived at a May 2000 meeting of NAS users, FAA managers, and NATCA representatives to discuss the National Airspace Redesign. The National Airspace Redesign is a multi-year effort to increase the efficiency of the NAS through the re-routing of air traffic, the reconfiguration of the nation's airspace, and more efficient air traffic management. Meeting participants suggested that the FAA concentrate on short-term actions to improve air traffic flow at a number of system choke points. The group identified seven problem areas in the area east of the Mississippi, as far north as Boston and as far south as Atlanta. This area includes airspace in the New England, Eastern, Great Lakes, and Southern regions, as well as many of the country's major population areas and most congested airports.

Figure 5-6, which identifies the seven national choke points, shows that the choke points are not actually discrete sites, but rather airways or sections of airspace. The figure also shows the extent to which the choke points overlap, so that congestion at one can easily create congestion at another.

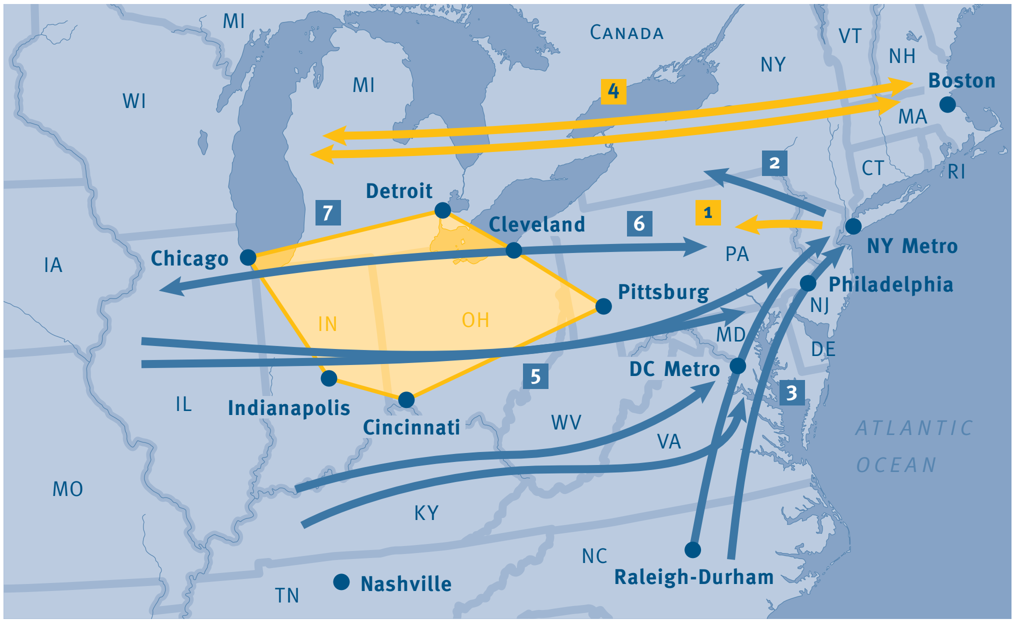


Figure 5-6
National Choke Points

Air traffic control specialists in the regional offices reviewed the problems at the seven choke points and identified a number of possible short-term solutions. In June 2000, the FAA prepared a national action plan to address the choke points. Of the plan's 21 action items, the first 11 were scheduled to be implemented or fully tested by the end of October 2000; the FAA expects to complete the entire choke point initiative by the end of FY 2002. The seven choke points, the problems faced at each, and the first set of action items to relieve the congestion are described below.

1 Westgate departures from the New York airports and west departures from Philadelphia

Flights departing through this choke point are affected by traffic initiatives, holding and departure stops. In addition, departures routed over the ELIOT fix feed three airways and the ELIOT fix is favored for NRP routes. Kennedy and Islip departures feed two airways over the Robinsville fix, near Philadelphia. Dulles and BWI arrivals descend through New York departures.

The FAA is re-routing propeller aircraft and Dulles arrivals, thereby reducing congestion and complexity in this airspace. This action results in fewer departure stops at the New York/New Jersey metropolitan area airports.

2 Northgate departures from the New York Airports and New York ARTCC Sector 34

The Elmira high-altitude sector (ZNY 34) is designed to handle a large volume of traffic flow to the Cleveland ARTCC. North American Route Program (NRP) crossing and converging traffic increases complexity. The result is holding, departure stops and miles-in-trail restriction on departures.

Departure stops from the New York/New Jersey metropolitan area have been decreased by reducing complexity in the high altitude airspace structure north and northwest of New York City.

3 Washington Center (ZDC) sectors at Robinsville, Yardley, and Hopewell

The Hopewell sector (ZDC 16) sequences and separates arrivals to Newark, Kennedy, and LaGuardia, Teterboro, Morrisville, and Philadelphia airports. The traffic flows over Beckley, Flat Rock, and Richmond. The Robinsville sector (ZDC 19) sequences arrivals to the New York TRACON over RBV, and can accommodate only three aircraft in a holding pattern. The Yardley sector (ZDC 18) is fed by one flow from sector 12 with traffic to LaGuardia, Teterboro, and Morrisville. Traffic is held now between 11,000 and 13,000 feet, with the New York TRACON flow at 14,000 feet.

An additional arrival gate into the New York TRACON will increase the throughput and decrease complexity in the mid-Atlantic airspace corridor. Implementation is expected by summer 2001.

4 Jet Route J547 Westbound

This jet route is the major westbound airway from the Boston ARTCC. Normally, traffic to Chicago O'Hare, Detroit, Chicago Midway, and Cincinnati on this route is slowed by miles-in-trail restrictions. Expanded miles-in-trail restrictions result in increased ground and airborne delays. The lack of alternate jet routes limits flexibility.

Flights are now being re-routed from the New England region through Canadian airspace, reducing congestion in en route airspace and providing greater access for New York departures.

5 Great Lakes corridor

When Cleveland ARTCC sectors 48 and 49 provide spacing for flights to multiple airports in the northeast, traffic backs up into the Minneapolis ARTCC, affecting departures from Chicago O'Hare to the south and the east. Indianapolis ARTCC sectors 88 and 89 sequence, space, and hold traffic for St Louis, Chicago O'Hare, Cincinnati, and Detroit. Cleveland ARTCC sectors 66 and 67 impose miles-in-trail restrictions for route J89 westbound, and also provide spacing for the Washington airports and holds for Philadelphia. Traffic must flow around the Buckeye MOA/ATCAA, just northeast of Cincinnati, when the military is using that airspace.

The FAA plans to modify NRP routes east of the Mississippi to reduce airspace complexity. In addition, certain restrictions will be placed on altitudes for short flights, which is expected to improve schedule predictability.

6 High altitude holding of East Coast Arrival Streams

High altitude en route holding of traffic in the Cleveland, Indianapolis, Chicago, and New York ARTCCs, especially traffic to Newark, JFK, Dulles, BWI, Reagan National and Philadelphia. Starts and stops leave sector volumes and capacities unpredictable. This impacts traffic at Chicago O'Hare, Detroit, Cleveland, Pittsburgh, and Cincinnati, incurring delays and unplanned departure stops.

Strategic spacing of aircraft at an earlier point of flights will reduce airspace complexity and the need for holding aircraft in higher altitudes.

7 Departure Access to Overhead Streams
Saturated overhead streams delay flights departing eastbound from Chicago O'Hare, east and southbound from Detroit, and north and eastbound from Cincinnati.

Flights from the Great Lakes region to the New York area will be re-routed through Canadian airspace to improve schedule predictability.

5.3.3 Department of Transportation Initiatives

The Department of Transportation (DOT) has undertaken several initiatives to improve passenger access to the U.S. aviation system. These initiatives involve the FAA but are administered by DOT.

5.3.3.1 One DOT Initiative

DOT recently embarked on a new, intermodal approach to transportation planning, called the One DOT management strategy. The FAA will participate in this program by considering the entire transportation experience of the flying public when determining its investments in airports and other aviation infrastructure. Examples of such initiatives include cooperation between the Federal Transit Authority and the FAA in developing light rail transit systems for JFK International in New York, Lambert Field in St. Louis, and other airports.

5.3.3.2 Federal Railroad Administration High Speed Ground Transportation Initiative

High Speed Ground Transportation, which includes both high-speed rail and magnetic levitation (Maglev), has the potential to alleviate highway and airport congestion. Maglev is a technology in which magnetic forces lift, propel, and direct a vehicle over a guideway. Maglev eliminates contact between the vehicle and the guideway, permitting speeds of up to 300 miles per hour, nearly twice the speed of conventional high-speed rail service. Maglev is expected to be competitive with cars and aircraft for trips in the 100- to 600-mile range.

The FAA and the Federal Railway Administration (FRA) recently conducted a study to determine under what circumstances a Maglev project could relieve congestion at one or more large airport. Several criteria were identified as important to the selection of a test airport:

- The airport should be in a densely populated metropolitan area, making major airport expansions unlikely given current environmental constraints.
- The airport should have a high level of connecting traffic, so that the burden of transferring would be no greater for rail passengers than for airline passengers.
- The cost savings from eliminating the delays associated with short-haul flight operations would be large enough to justify the cost of a Maglev alternative.

The FAA evaluated a number of highly congested airports, including Los Angeles, Chicago O'Hare, Atlanta, and Dallas/Fort Worth and selected Los Angeles (LAX) as a possible candidate for a Maglev project. Since more than five percent of LAX's traffic is to and from airports in the Los Angeles metropolitan area, one of those airports, Santa Barbara Municipal Airport (SBA), was selected as the other terminus of the Maglev line. In the summer of 1999, there were 72 daily flights between LAX and SBA.

FRA's Office of Railroad Development requested data from the FAA on the cost of delays imposed by the short-haul flights between LAX and SBA. As part of its ongoing research, the FAA had identified the marginal delay of an additional operation at LAX. The FRA developed a cost of delay model for this study, using the actual fleet mix at LAX to determine the hourly direct operating costs and a representative cost for passenger time. The study found that each short-haul flight imposed a cost of nearly $2,000 on the airport system. The study also estimated the impact of traffic growth and found that if there are no airside improvements at LAX and the number of operations increase by ten percent, the cost of the delay would increase sharply, to as much as $5,000 per flight.

In 1999, the Department of Transportation awarded grants to seven states and local authorities for the pre-construction planning of Maglev projects. These funds will cover up to two-thirds of the cost of the preliminary engineering, market studies, environmental assessments, and financial planning needed to determine the feasibility of deploying a Maglev project. Included among these grants was one in the Los Angeles metropolitan area. Following the preliminary assessments, DOT will choose one of the seven proposals for the construction of a Maglev project.